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Solid Waste Disposal Issues and Dental Amalgam

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Introduction

While environmental concerns related to dentistry continue to focus on the heavy-metal content of wastewater [1], issues involving solid-waste disposal of amalgam have the potential to become equally significant. Two recent papers describe the residual mercury (Hg) content of disposable amalgam capsules [2,3] with the latter reporting values as high as 33.89 mg Hg per capsule [3]. The Naval Dental Research Institute (NDRI) has continued to evaluate residual Hg levels from currently available capsules and obtain information on the leaching potential of Hg and silver (Ag) from used dental-amalgam capsules. Leaching of these metals above regulatory levels could make the disposal of these capsules a vexing issue for U.S. Navy dental treatment facilities.

Regulatory Background

The policy that governs the disposal of solid waste in the United States is promulgated in the Resource Conservation and Recovery Act (RCRA) [4]. Through this act Congress provided the Environmental Protection Agency (EPA) with the foundation to develop regulatory programs to manage solid waste, hazardous waste, medical waste, and underground storage tanks. In 1965, Congress enacted the Solid Waste Disposal Act (SWDA), which provided the first federal statutory requirements intended to improve solid-waste disposal practices. The SWDA was modified in 1970 by the Resource Recovery Act, and modified again in 1976 by RCRA. RCRA established a system for controlling hazardous waste from its point of generation to its final disposal (cradle-to-grave).

RCRA has been amended many times since 1976, most notably by the Hazardous and Solid Waste Amendments (HSWA) of 1984. HSWA was fashioned principally in response to citizen concerns that existing methods of hazardous waste disposal were not safe or sufficient. The Federal Facilities Compliance Act modified RCRA again in 1992. This act made the federal government part of the regulated community, and it holds government facilities and managers to the same array of enforcement measures, including fines and penalties, as the rest of the nation. The latest legislative change to RCRA was the Land Disposal Program Flexibility Act of 1996, which provided regulatory flexibility for the land disposal of certain hazardous wastes.

Facilities that generate less than 100 kilograms (220 pounds) of hazardous waste per month or less than 1 kilogram (2.2 pounds) per month of acutely hazardous waste are excused from most federal RCRA requirements and are classified as “Conditionally Exempt Small Quantity Generators” (CESQGs) [4].

An essential caveat to this exemption is that some states prohibit the disposal of *any* hazardous waste into municipal solid-waste landfills, even from CESQGs. The potential exists for dental offices to be in violation of state solid-waste discharge regulations if used amalgam capsules are discarded into municipal solid-waste landfills. Facilities that produce solid waste should contact local, regional, and state solid-waste regulators to confirm regulatory requirements.

TCLP

To help determine if a waste is hazardous, the EPA designed a laboratory analysis entitled Toxicity Characteristic Leaching Procedure (TCLP) [5,6], which determines the mobility of analytes in an acetic acid buffer solution. The concentration of regulated analytes in the extract determines the toxicity characteristic of a sample, and therefore whether it is subject to disposal regulations under RCRA. Disposal regulations can make the process of waste management onerous, time consuming and costly.

TCLP was designed to predict whether landfill wastes might leach dangerous levels of chemicals into ground water. TCLP regulatory levels exist for 40 different toxic chemicals. The limits for Hg and Ag are 0.2 mg/liter and 5.0 mg/liter, respectively [5,6].

Residual Mercury Content and TCLP Analysis of Used Capsules

In a recent study [7], residual Hg determinations and TCLP analysis of used amalgam capsules were carried out by NDRI personnel. For residual Hg analyses, 25-capsules from each of 10-different brands of amalgam were analyzed. Total residual Hg levels per capsule were determined using EPA method 7471. For TCLP analysis, 25-amalgam capsules for each of 10 brands were extracted using a modification of EPA method 1311. Hg analysis of the TCLP extracts was done with method 7470A. Analysis of Ag concentrations in the TCLP extract was done with EPA method 6010B.

Mean residual Hg per capsule ranged from 0.125 to 1.255 mg/capsule. Analysis utilizing the Duncan multiple range test resulted in the segregation of the ten brands into three groups: Dispersalloy™ capsules, Group A, retained the most Hg. These capsules were the only ones to include a pestle. Group B capsules all were ultrasonically sealed and included the following brands: Valliant PhD™, Optaloy™ II, Megalloy™, and Valliant Snap Set™. This group retained the next highest level of Hg, and was characterized by a groove in the inside of the capsule. Group C, Tytin™ regular set double-spill, Tytin FC™, Contour™, Sybraloy™ regular set, and Tytin™ regular set single-spill retained the least amount of Hg.

The Dispersalloy™ capsules retain more Hg than any other capsule, possibly due to the unique use of a pestle. Only two brands did not use an Hg packet, and it did not appear from the available comparisons that the packets influenced Hg retention. A dramatic effect was associated with the presence of a groove on the inside of the ultrasonically sealed capsules. There was no overlap in means between brands that had and those that did not have a groove, and the Duncan multiple range test confirmed this grouping. Within the groove and no groove brands, more Hg was retained by double- than by single-spill capsules, but these effects were not statistically significant using these post-hoc testing procedures.

TCLP analysis of the triturated capsules showed Sybraloy™ and Contour™ leached Hg at greater than the 0.2 mg/liter RCRA limit. The Contour™ extract had an Hg concentration of 0.4120 mg/liter and the Sybraloy™ extract had an Hg concentration of 0.2530 mg/liter. None of the capsules leached Ag above RCRA limits (5 mg/liter). All extracts were at non-detectable levels for Ag (< 0.0500 mg/liter). It is of interest to note that the brands that retained the most Hg did not have the highest Hg levels in the TCLP extracts. This surprising and unanticipated result is now the subject of further research.

Mercury Release During Trituration

The United States Air Force Dental Investigation Service (USAF DIS) has documented the release of Hg during the trituration process from some brands of dental amalgam [8]. The released Hg can contaminate amalgamators making the end-of-life disposal of these units problematic. Severely contaminated amalgamators may need to be disposed of as hazardous waste or processed at retorting facilities. This Hg release is especially severe in old style operator-activated Tytin™ capsules. While these capsules are no longer on the market, a significant number remain in inventories throughout the Navy.

Mixing Failure

In some cases, capsules that contain Hg packets do not mix properly due to failure of the packets to "break open" during trituration. This phenomenon can be seen across many different brands that use Hg packet technology. Anecdotal reports from several Navy dental clinics confirm this problem, which can be particularly severe in some lots of the same amalgam brand. Unbroken Hg packets can create a serious disposal dilemma as they contain sizeable amounts of elemental Hg. Hg packets from unmixed capsules should be kept in the same tightly capped scrap amalgam containers as the amalgam scrap. **They should never be suctioned in high-volume evacuation systems or disposed of in general operatory waste or in infectious waste bags that will be incinerated.**

Mercury Hygiene

The American Dental Association has published recommendations for the appropriate use and handling of dental amalgam [9]. These recommendations are briefly summarized here:

- Training of all personnel about the need for appropriate hygiene practices when working with amalgam and amalgam-contaminated instruments. Training should include the presentation of relevant environmental and waste management regulations. These regulations may vary on a state-by-state basis, and local dental societies should be contacted when information about disposal regulations is needed. An excellent Hg hygiene training presentation is available through the United States Air Force Dental Investigation Service web site [10].

- Work areas should be well ventilated to prevent the build up of Hg vapor. Patient treatment and work areas should be monitored for Hg vapor on a routine basis and in the event of Hg spills. Industrial hygienists trained in the use of Hg vapor analyzers should do the monitoring.

- Flooring should be nonabsorbent, seamless and easy to decontaminate.

- Use only predosed precapsulated amalgam. Bulk Hg should be turned in or sold to recyclers.

- Use of amalgamators with enclosed mixing areas that will contain any Hg that leaks out during trituration.

- Avoid handling freshly mixed amalgam or Hg with unprotected skin. Used amalgam capsules should be recapped and disposed of appropriately.

- High-volume oral evacuation equipment should be used when placing, finishing or removing amalgam.

- Amalgam traps should be cleaned out daily and the used amalgam should be collected for recycling. **Amalgam traps should never be rinsed in sinks or into the high-volume evacuation lines.**

- Scrap amalgam should be stored dry in a tightly capped container. Storing scrap amalgam under photographic or radiographic fixer creates disposal problems for the fixer solution and some amalgam recyclers will not accept wet amalgam scrap.

- Never dispose of Hg contaminated wastes into containers that will be incinerated. Incineration of used capsules should be avoided to avert volatilization of Hg to the atmosphere. Deposition of atmospheric Hg to land, lakes, rivers, and streams can be substantial [11] and lead to the creation of organic Hg that bioaccumulates in fish and other aquatic organisms [11-20]. Nearly 100% of the Hg that concentrates in fish tissue is methylmercury [11,20]. High Hg levels in remote pristine lakes, where atmospheric deposition appears to be the key instrument of contamination, is further evidence of the importance of this pathway [11,18].

- Clean up spills using trap bottles, tapes, or freshly mixed amalgam. Amalgam spill kits are also available commercially [21]. Never "vacuum" Hg with the high-volume evacuation system, as this will release Hg to the wastewater stream. Household vacuum cleaners should never be used to clean up Hg spills as this can volatize Hg and will contaminate the vacuum.

Summary

The extensive quantity of residual amalgam and the demonstrated capacity of Hg to leach from used capsules may make their disposal exigent and problematic. The meticulous and systematic efforts of all members of Navy Dental Commands are necessary and indispensable for the successful management of amalgam waste. The control of hazardous wastes and pollutants from dental treatment facilities is consistent with the provision of the highest quality dental care and enhances the mission of the Navy Dental Corps in preparing Sailors and Marines to function successfully in the fleet.

Recommendations

Scrap amalgam should be stored dry and recycled through either the Defense Reutilization Marketing Office (DRMO) or through licensed mercury retorting or recycling facilities. NDRI has compiled a database of licensed amalgam recyclers. For more information please contact CAPT James C. Ragain, DC, USN, Commanding Officer, Naval Dental Research Institute, Building 1-H, 310A B Street, Great Lakes, IL60088-5259.E-mail: james.ragain@ndri.med.navy.mil

Whenever possible, used amalgam capsules should be recapped prior to disposal (unfortunately this is not possible with the ultrasonically sealed capsules). It is prudent to confirm that dental operatory solid-waste that includes used amalgam capsules and other amalgam-contaminated waste, is sent to landfills for disposal and is not incinerated. Some areas of the country routinely burn solid waste.

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